USERS MANUAL
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FOR

GODDARD ORBIT DETERMINATION PROGRAM

April 1965

Contract No.: NAS-5-3509

Prepared by

Sperry Rand Systems Group
Sperry Gyroscope Company
Division of Sperry Rand Corporation
Great Neck, New York

(Sperry Report No. AB-1210-0038-2)

for

Goddard Space Flight Center
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INTRODUCTION

The information in this manual is intended as a guide to those desiring to use the Orbit Determination Program. The material herein has been divided into four main sections.

Section 1. contains a general description of program usage. It discusses the major subdivisions of the program and each of their sub-modes. Also covered in this section are the various options available to the user in each subdivision.

Section 2. is devoted to a complete description of how program input is to be set up. This section lists by name all variables which may be read in. It gives the input section number, location by card count, the format and description of each input variable.

Section 3. provides a complete description of the output available to the user. It explains how the frequency of output may be controlled. The options available in each subdivision are listed and the method by which they are specified by the user is explained.

In Section 4., a description is given of operating procedures to be followed in the running of the Orbit Determination Program. A typical deck set-up is included for the user's information and tape assignments are discussed. There is a discussion of the two sub-programs into which Subdivision B2 has been divided. Some recommended procedures for operating efficiency are also described.

This manual was prepared under Contract NAS-5-3509 for the Theoretical Division (Special Projects Branch) of the Goddard Space Flight Center, Greenbelt, Maryland.

1.0 GENERAL DESCRIPTION OF PROGRAM USAGE

The program is coded entirely in the FORTRAN IV language and runs under the IBSYS/IBJOB operating system. It has three major subdivisions, viz.,

a) A Mode – Computation of vehicle ephemeris and generation of associated observations;

b) B1 Mode – Statistical processing of data considering just six basic states (three position and three velocity);

c) B2 Mode – Statistical processing of data with capability of specifying up to twenty additional states.

The following sections will describe these subdivisions in more detail.

1.1 A MODE

This subdivision can be broken down into four sub-modes:

a) The computation of vehicle ephemeris only;

b) Generation of observations for up to twenty-five ground stations and one on-board system; both observations and ephemeris printed;

c) Same as (b) with the additional facility for writing observations onto tape in a format suitable for processing by subdivisions B1 and B2;

d) Down range prediction, in which the following are standard outputs:

   i) the time at which a vehicle comes in view of a ground station;

   ii) the total time in sight

   iii) observation quantities while in sight

   iu) the time of polar baseline and meridian crossings

1.1.1 TRAJECTORY COMPUTATION OPTIONS

The user has the option of selecting either the Encke or Cowell special perturbation technique or of suppressing all perturbations and using the two-body solution alone.

The Encke integration is single precision, the two-body component being computed in double precision. The Cowell method is double precision throughout.

The perturbations available to the user include the sun, moon, and five near planets, 38 harmonic coefficients of the earth's oblateness, solar radiation pressure, air drag and thrust. The planets contributing perturbations can be individually selected as can the total number and order of each individual harmonic coefficient. The air density tables are composed of the U.S. Standard Atmosphere of 1962 (up to 250 km.) and Harris-Preister Tables from 100 km. up to 1100 km. In the overlapping regions, an average of the values given by the two models is used.

The Harris-Priester model is a function of solar flux, altitude and local sun time. Solution for the density from these tables requires interpolation in all three variables.

The solar pressure routine contains provisions for computing the solar illumination factor as continuously variable from 1 to 0 as the vehicle travels from full sunlight through penumbra into the umbral region.

The integrator used in both the Encke and Cowell methods is a modified Adams method due to Nordsieck. The step size can be varied at any time during a run on a continuously variable basis, thereby eliminating the need of switching to Runge-Kutta-Gill to attain times not integral increments of the step size. Runge-Kutta-Gill is nonetheless required as a starting procedure for the Nordsieck method.

1.1.2 OTHER OPTIONS

The following observations can be generated:

a) Azimuth

b) Elevation

c) Range

d) Range-Rate

e) Hour-Angle

f) Declination

g) l direction cosine

h) m direction cosine

i) X Antenna Angle

j) y Antenna Angle

k) Range equivalent

l) Range-rate equivalent

m) One way Doppler

n) Two way Coherent Doppler

o) Two Way Pseudo Doppler

p) Radar Altimeter Ranging

q) Stadiometric Ranging

r) Planet to Planet Angle

s) Star to Planet Angle

t) Star to Landmark Angle

u) Landmark to Landmark Angle

v) Radar Occultation

w) Star Occultation

The user can input initial conditions in several coordinates and in several systems of units, at his option. In addition to these coordinate system options, the input conditions can be precessed, nutated, and librated for conversion to the proper inertial system.

The input is set up so that a run can be made using many items that are considered standard. Such items include print intervals, rectification criteria, integration intervals and similar variables. These standard inputs have three degrees of precision. That is, step size and rectification criteria, the number of planets and number of harmonics in oblateness are a function of precision and accuracy requirements. The user has a choice of three levels. If the standards are not to his liking, however, he can overwrite any or all of them by using additional input information.

Other options include the application of precession, nutation and libration transformations to the oblateness of the earth and moon, and the printing of times when the vehicle crosses into and out of the penumbral region of the reference body. In the case of the earth-moon system, passage of the vehicle into and out of these same regions for the non-reference body is also available for printing out.

1.2 B1 MODE

In this subdivision, the user has a choice of one of six sub-modes:

a) Orbit determination, including the processing of real data;

b) Orbit determination using artificial data with the addition of noise;

c) Error Analysis

d) Propagation of Covariance matrix

e) Propagation of Miss Coefficients

f) Data Scanning

The first three modes involve the reading of a properly formatted data tape. In the first mode real data is used while in the second the tape contains simulated errorless data, to which noise with selected random error can be applied. In the third mode, the program assumes zero observation error so that the nominal trajectory is followed and the covariance matrix reflects the error under true tracking conditions.

The fourth mode provides for propagation of the covariance matrix along a nominal trajectory when data are not available and the fifth mode provides miss coefficients.

The sixth mode reads the data tape and computes residuals between the data and the assumed trajectory. This information allows the user to find bad data points which are not usually obvious when the raw data are scanned.

1.2.1 OTHER OPTIONS

The added options which the user has at his disposal include:

a) a flexible print system;

b) ability to reject data of any type from any station;

c) ability to ignore data of a given type and from a given station until a specified time;

d) ability to specify N and then have one of each Nth observation of a given type from a given station processed;

e) application of refraction correction;

f) selection of corrections for time delay

g) ability to reject data whose residual exceeds a specified statistical level;

h) provision of statistical uncertainty of each observation type as input;

i) provision to print, in summary form, observation time, station number, observed value and residual of each point processed.

1.3 B2 MODE

This subdivision allows the user to consider as states up to twenty additional variables. These twenty variables can be chosen from a total of some 800 different variables. For example, states can be chosen from all of the planetary gravitational parameters, all of the oblateness harmonics of the earth and moon, the velocity of light, solar flux and area-to-mass ratio of the satellite. Further, for each of the twenty-five stations, three components of station location, three components of station angular orientation, six components of refraction, and a bias error in each observation type can be selected.

Other features of this maximum state version are identical to those of the minimum state version. Both a Bayes and a minimum variance version are available with both Cowell and Encke integrators. In each version, the input options discussed previously are available. The only difference is that no provisions for handling powered flight are included in the B2 subdivision.

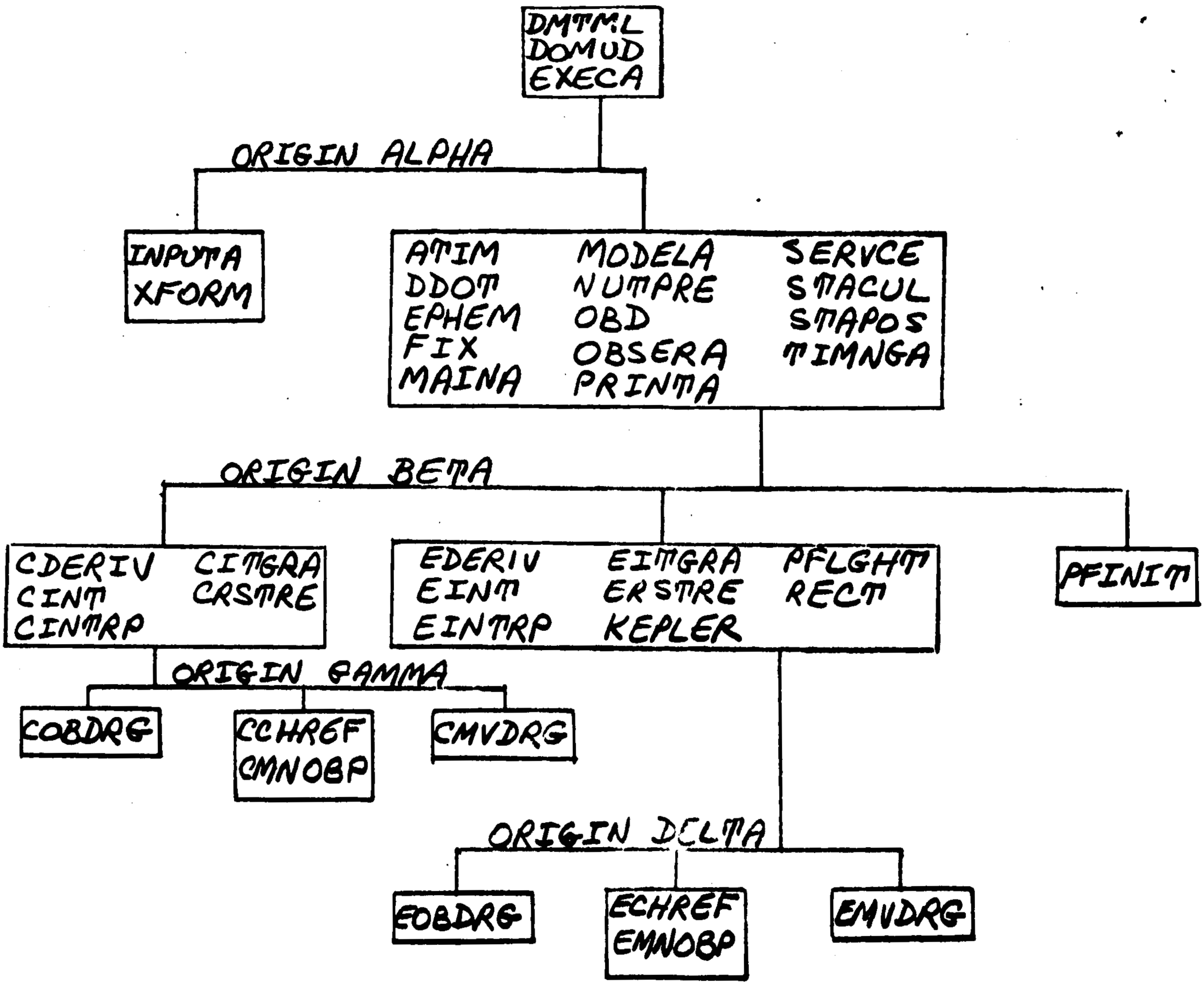

Figure 1

Overlay Structure for Subdivision A

2. GENERAL DESCRIPTION OF INPUT

The Specifications Input is defined as that input which supplies initial conditions, case parameters, station information and control options.

In each of the three program subdivisions (A, B1, and B2), there is a subroutine whose function is reading the Specifications Input and performing necessary initialization. The names of these subroutines are:

(a) INPUTA ;

(b) INPTB1 ;

(c) B2INPT .

The Specifications Input for each of the three subroutines begins with the reading of a card which contains the major program-defining parameters. The remainder of the input is divided into two groups.

The first group is composed of information which must be specified by the user. Included in this group are such items as launch time, initial vehicle position and velocity, and perturbations to be included in the trajectory computation.

The information in the second group is not necessarily supplied by the user. He can choose to accept a set of values described as standard. If he decides to use standard values, he has the choice of low, intermediate or high precision. Furthermore, he can overwrite as many of these standard values as he wishes. Included in this second group of input values are integration step sizes, the number, type and value of oblateness coefficients to be used, and the rectification criteria to be used in the run.

Each group of inputs is broken down into several sections. The first data card of any section to be read must be the section number, in integer format, in columns four and five.

For purposes of stacking cases, the user may choose to bypass any or all sections of the first group except that section which terminates the group. The same applies for the second group with the additional constraint that calling for standard values re-initializes the variables concerned.

The following sections give a detailed description of the input format. The quantity in the description column is entered on the specified card of the section in the appropriate columns. The name given is the name used for the quantity in the program.

2.1 INPUT FOR SUBDIVISION A

Sect.	Card	Cols.	Name		
	1	2-5	KSTDRD	I5	<0 WILL WANT AT LEAST SOME STANDARD INPUTS
					≥0 NO STANDARD. ALL VALUES WILL BE READ IN.
		6-10	MDE	I5	=1 TRAJECTORY COMPUTATION
					=2 OBSERVABLE COMPUTATIONS WITHOUT SIMULATED DATA
					=3 OBSERVABLE COMPUTATIONS WITH SIMULATED DATA
					=4 PREDICTION MODE
		11-15	PRECIS	F5.0	=1 LOW PRECISION LEVEL
					=2 INTERMEDIATE PRECISION LEVEL
					=3 HIGH PRECISION LEVEL
		16-20	CEPID	F5.0	=0,1 ENCKE INTEGRATION
					=-1 COWELL INTEGRATION

FIRST GROUP OF INPUTS

1	1	2-72	ITITLE(1-12)	12A6	TITLE
	2	2-5	NYEARP	I5	YEAR OF LAUNCH
		6-10	DAYS	F5.0	DAY OF LAUNCH
		11-15	HRS	F5.0	HOUR OF LAUNCH DAY
		16-20	HMIN	F5.0	MINUTE OF LAUNCH HOUR
		21-40	SEC	D20.16	SECONDS OF LAUNCH MINUTE
	3	1-24	TMAX	D24.16	TIME OF RUN IN HOURS
2	1	2-5	KLM	I5	INDICATOR FOR UNITS OF POSITION AND VELOCITY VECTOR
					=1 KM,KM/SEC
					=2 ER,ER/HR
					=3 FT,FT/SEC
					=4 MI,MI/HR
					=5 NM,NM/HR
					=6 NM,FT/SEC
					=7 AU,AU/HR
		6-10	KLM1	I5	INDICATOR FOR COORDINATE SYSTEM OF INPUT VECTORS
					=1 CARTESIAN COORD. WE=0
					=2 CARTES. COMPUTE WE
					=3 GEODETIC LONG,LAT,ALT,VE,VN,VH; WE=0
					=4 GEODETIC LONG,LAT,ALT,VE,VN,VH; COMPUTE WE
					=5 GEODETIC LONG, LAT, ALT, V, γ, AZ; WE=0
					=6 GEODETIC LONG, LAT, ALT, V, γ, AZ; COMPUTE WE
					=7 GEOCENTRIC RA, DECL, ALT, VRA, VD,VH; WE=0
					=8 GEOCENTRIC RA, DECL, ALT, VRA, VD, VH; COMPUTE WE
					=9 GEOCENTRIC RA, DECL, ALT, V, ,AZ; WE=0
					=10 GEOCENTRIC RA, DECL, ALT, V, γ ,AZ; COMPUTE WE

Sect.	Card	Cols.	Name	Type	Description
2 cont.		11-15	KLM2	I5	INDICATOR FOR NUTATION AND PRECESSION OF INPUT VECTOR =0 NO =1 YES
		16-20	KSNAP	I5	INDICATOR FOR NUTATION AND PRECESSION OF VECTORS DURING RUN =0 NO =1 YES
		21-25	KLM3	I5	INDICATOR FOR LIBRATION OF INPUT VECTORS =0 NO =1 YES
		26-30	KLIBR	I5	INDICATOR FOR LIBRATION OF VECTORS DURING RUN =0 NO =1 YES
		31-35	MRREF	I5	INDICATOR FOR INITIAL REFERENCE BODY =1 EARTH =2 SUN =3 MOON =4 MARS =5 VENUS =6 JUPITER =7 SATURN
	2	1-24	RCIN(1)	D24.16	INITIAL POSITION VECTOR
		25-48	(2)	D24.16	SEE KLM AND KLM1
		49-72	(3)	D24.16	
	3	1-24	RDCIN(1)	D24.16	INITIAL VELOCITY VECTOR
		25-48	(2)	D24.16	SEE KLM AND KLM1
		49-72	(3)	D24.16	
3	1	2-5	PASFX	F5.0	TOTAL NUMBER OF PASSES
4	1	2-5	KS2BY	I5	INDICATOR FOR TWO-BODY INTEGRATION ONLY =0 NO =1 YES
		6-10	KSPLT	I5	INDICATOR FOR INCLUSION OF PLANETARY PERTURBATIONS =0 NO =1 YES
		11-15	KSOBL	I5	INDICATOR FOR INCLUSION OF OBLATENESS PERTURBATION =0 NO =1 YES
		16-20	KSDRG	I5	INDICATOR FOR INCLUSION OF EARTH DRAG PERTURBATION =0 NO =1 YES
		21-25	KSRAP	I5	INDICATOR FOR INCLUSION OF RADIATION PRESSURE PERTURBATION =0 NO =1 YES
		26-30	KSDRGM	I5	INDICATOR FOR INCLUSION OF MARS DRAG PERTURBATION =0 NO =1 YES

Sect.	Card	Cols.	Name	Type	Description
4 cont.		31-35	KSDRGV	I5	INDICATOR FOR INCLUSION OF VENUS DRAG PERTURBATION =0 NO =1 YES
		36-40	KSMNOB	I5	INDICATOR FOR INCLUSION OF MOON OBLATENESS PERTURBATION =0 NO =1 YES
		41-45	KRF	I5	INDICATOR FOR INCLUSION OF REFRACTION EFFECTS =0 NO =1 YES
		46-50	KECLPS	I5	INDICATOR FOR INCLUSION OF ECLIPSE INFO PRINT =0 NO =1 YES
5	1	2-5	MAXSTA	I5	TOTAL NUMBER OF STATIONS USED IN RUN
	2	2-5	K	I5	STATION NUMBER
		10-15	STANM(L)	A6	STATION NAME
		20-30	TYPE(L)	4XI11	A(1)+1.E2*A(2)+1.E4*A(3)+1.E6*A(4)+1.E8*K WHERE A=OBSERVATION TYPES USED BY STATION K IN ASCENDING ORDER L=PACKED STATION NUMBER
	3	1-24	STALT(K)	D24.16	LATITUDE OF STATION K
		25-48	STALN(K)	D24.16	LONGITUDE OF STATION K
		49-72	STAHT(K)	D24.16	ALTITUDE OF STATION K
	4	1-36	RRATE(1,L)	D36.16	REPETITION RATES (HRS)
		37-72	RRATE(2,L)	D36.16	FOR EACH OBSERVATION
	5	1-36	RRATE(3,L)	D36.16	TYPE
		37-72	RRATE(4,L)	D36.16	
	6	1-18	TDELAY(1,L)	E18.8	TIMES IN HRS BEFORE WHICH
		19-36	TDELAY(2,L)	E18.8	EACH OBSERVATION IS NOT
		37-54	TDELAY(3,L)	E18.8	TO BE COMPUTED
		55-72	TDELAY(4,L)	E18.8	
	7	1-18	FUP(K)	E18.8	STA. TRANSMIT FREQ. (MC/S)
		19-36	FDOWN(K)	E18.8	STA. RECEIVE FREQ. (MC/S)
	8	1-24	STAOR(NCDST+1)	D24.16	ΔEE STA. ROTATION ANGLE
		25-48	STAOR(NCDST+2)	D24.16	ΔEV STA. ROTATION ANGLE
		49-72	STAOR(NCDST+3)	D24.16	ΔEN STA. ROTATION ANGLE
	9	1-24	STAOR(NCDST+4)	D24.16	U STATION LOCATION
		25-48	STAOR(NCDST+5)	D24.16	V ERRORS CAUSED BY
		49-72	STAOR(NCDST+6)	D24.16	W GEODETIC NET ERROR
	10	1-24	STAOR(NCDST+7)	D24.16	NO REFRACTIVITY AT STA.
		25-48	STAOR(NCDST+8)	D24.16	H TROPOSPHERE SCALE FACT
		49-72	STAOR(NCDST+9)	D24.16	PO MAX. ELECTRON DENSITY
	11	1-24	STAOR(NCDST+10)	D24.16	HO LOWER LIMIT OF IONO-
		25-48	STAOR(NCDST+11)	D24.16	HM HT OF PO (KM)
		49-72	STAOR(NCDST+12)	D24.16	-OPEN-
	12	1-24	STAOR(NCDST+13)	D24.16	ΔT FOR TIMING
		25-48	STAOR(NCDST+14)	D24.16	BIAS ADDED FOR OBSER.A(1)
		49-72	STAOR(NCDST+15)	D24.16	BIAS ADDED FOR OBSER.A(2)
	13	1-24	STAOR(NCDST+16)	D24.16	BIAS ADDED FOR OBSER.A(3)
		25-48	STAOR(NCDST+17)	D24.16	BIAS ADDED FOR OBSER.A(4)

REPEAT CARDS 2-13 FOR EACH STATION

Sect.	Card	Cols.	Name	Type	Description
6	1	1-18	DAREAS	E18.8	EFFECTIVE SURFACE AREA OF VEHICLE PERTAINING TO DRAG
		19-36	PAREAS	E18.8	EFFECTIVE SURFACE AREA PERTAINING TO RADIATION PRESSURE
		37-54	SPADD(6)	E18.8	MASS OF VEHICLE
7	1	2-5	MAXLUN	I5	MAXIMUM NUMBER OF LUNAR LANDMARKS
		6-10	IPLNT	I5	NUMBER OF PLANET TO BE USED FOR CALCULATING ONBOARD OBSERVATIONS
		11-15	ISTAR	I5	NUMBER OF STAR TO BE USED FOR CALCULATING ONBOARD OBSERVATIONS
	2	1-72	STAR(1,1-4)	4E18.8	TABLES NEEDED BY ONBOARD SUBROUTINE
	3	1-72	STAR(1,5-8)	4E18.8	GIVING POSITIONS OF REFERENCE STARS
	4	1-72	STAR(1,9-10) STAR(2,1-2)	4E18.8	AND LANDMARKS. STAR(1,I) AND STAR (2,I) ARE DECLINATION AND RIGHT
	5	1-72	STAR(2,3-6)	4E18.8	ASCENSION RESPECTIVELY, OF THE ITH
	6	1-72	STAR(2,7-10)	4E18.8	STAR. POSLUN(1,I) AND POSLUN(2,I)
	7	1-72	POSLUN(1,1-4)	4E18.8	ARE LATITUDE AND LONGITUDE, RESPECT-
	8	1-72	POSLUN(1,5-8)	4E18.8	IVELY, OF THE ITH LANDMARK IN THE
	9	1-72	POSLUN(1,9-10) POSLUN(2,1-2)	4E18.8 4E18.8	LUNAR COORDINATE SYSTEM.
	10	1-72	POSLUN(2,3-6)	4E18.8	
	11	1-72	POSLUN(2,7-10)	4E18.8	
8	1	2-5	IUNIT	I5	INDICATOR FOR OUTPUT UNITS(SEE KLM)
		6-55	IPSEC(I),I=1,10	10I5	INDICATORS FOR SUPPRESSION OF EACH OF 10 PRINT SECTIONS
	2	1-18	DTPI	E18.8	PRINT PORTION (HRS) AND
		19-36	DTSUP	E18.8	SUPPRESS PORTION (HRS), OF TOTAL PRINT PERIOD
		37-54	PRATE	E18.8	INTERVAL WITHIN DTPI AT WHICH TO PRINT
9	1	2-5	NPFSET	I5	NUMBER OF POWERED FLIGHT SETS (UP TO 3)
	2	1-72	PFPAR(I,1-3)	3D24.12	TIME START, TIME END, FX
	3	1-72	PFPAR(I,4-6)	3D24.12	FY, FZ, MASS.
	4	1-72	PFPAR(I,7-9)	3D24.12	MASS RATE, T-INTEG, Δ-PNT

REPEAT CARDS 2-4 FOR EACH I WHERE I=1, NPFSET

10 END OF FIRST SET OF INPUTS

PROGRAM ADVANCES TO 2ND GROUP OF INPUTS. IF KSTDRD IS NEGATIVE, STANDARD VALUES ARE COMPUTED AND PROGRAM BEGINS TO READ IN 2ND SET OF INPUTS TO CHANGE OR AUGMENT ANY OF THESE STANDARDS. IF KSTDRD NOT NEGATIVE, ALL VALUES ARE READ IN, ELSE VALUES FROM PREVIOUS STACKED CASE ARE USED.

1	1-7	1-72	(DT3(I,J), I=1,3) J=1,7	3D24.12	INTEGRATION INTERVALS FOR EACH OF 7 WORKING BODIES FOR NEAR, MEDIUM AND FAR REFERENCE
2	1	1-72	R1(1-3)	3D24.12	R1 AND R2 ARE DISTANCES IN
	2	1-72	R1(4-6)	3D24.12	E.R. FOR EACH OF 7 WORKING
	3	1-72	R1(7), R2(1-2)	3D24.12	BODIES FOR SWITCHING FROM
	4	1-72	R2(3-5)	3D24.12	NEAR TO MEDIUM AND MEDIUM TO
	5	1-48	R2(6-7)	2D24.12	FAR INTEGRATION INTERVALS.

Sect.	Card	Cols.	Name	Type	Description
3.	1	1-24	RT1	D24.12	VALUES USED AS TOLERANCES IN
		25-48	RT2	D24.12	RECTIFICATION CRITERIA
4	1	1-18	DH1	E18.8	TROPOSPHERE INTEGRATION STEP SIZE (KM)
		19-36	DH2	E18.8	IONOSPHERE INTEGRATION STEP SIZE (KM)
		37-54	H2	E18.8	UPPER LIMIT TROPOSPHERE (KM)
		55-72	H4	E18.8	UPPER LIMIT IONOSPHERE (KM)
5	1	2-5	KOBLAT	I5	NUMBER OF OBLATENESS COEFFS
	2	2-5	M	I5	M INDEX
		6-10	N	I5	N INDEX
		11-15	ISORC	I5	INDICATOR FOR C OR S COEFF. =0 S =1 C
	3	1-24	SORCCF	D24.12	VALUE OF COEFFICIENT
REPEAT CARDS 2-3 UNTIL KOBLAT VALUES HAVE BEEN READ IN.					
6	1	2-5	MBMAX	I5	NUMBER OF WORKING BODIES
		6	KWBMU(I), I=1,MBMAX(MBMAX)*	I5	INDICES OF WORKING BODIES
	2	1-72	TPMAT8(I), I=1,MBMAX	3D24.12	GRAVITATIONAL CONSTANTS OF WORKING BODIES
REPEAT CARD 2 FOR EACH VALUE OVER 3N NEEDED					
7	1	1-24	DYN(48)	D24.12	SOLAR FLUX
		25-48	DYN(49)	D24.12	OPEN
8	1	1-72	DYN(51-53)	3D24.12	COEFFS. FOR LUNAR OBLATENESS
9	1	1-24	COMB(1)	D24.12	VELOCITY OF LIGHT
10	1	1-72	PRNT3(1-3)	3D24.12	PRINT INTERVALS(HRS) FOR NEAR MEDIUM AND FAR REFERENCE
11	1	1-24	EMIN	D24.12	MINIMUM VALUE OF ELEVATION ANGLE(RAD)
12	1	1-18	RTO	E18.8	RATIO OF NORDSIECK INTEGRATION INTERVAL TO THAT IN RUNGE-KUTTA
13	1	1-24	DSPL	D24.12	SPECIAL INTEGRATION INTERVAL IN A4 MODE TO OBTAIN ACQUISITION TIME (HRS)
14	1	1-72	RATEV(1-3,1)	3D24.12	ROTATION VECTOR USED IN MARS DRAG COMPUTATIONS
	2	1-72	RATEV(1-3,2)	3D24.12	ROTATION VECTOR USED IN VENUS DRAG COMPUTATIONS
15	1-10	1-72	XMACH(I), I=1,40	4E18.8	MACH NUMBER TABLE
	11-20	1-72	CDT(I), I=1,40	4E18.8	DRAG COEFFICIENT TABLE
16	1	1-20	SPADD(7)	E20.8	TOLERANCE FOR CONVERGENCE OF NEWTON-RAPHSON SCHEME IN OCCULTATION SUB-ROUTINE
		21-25	IXADD(15)	I5	MAXIMUM NUMBER OF NEWTON-RAPHSON ITERATIONS IN OCCULTATION SUBROUTINE

Sect.	Card	Cols.	Name	Type	Description
		26-30	IXADD(16)	I5	FLAG FOR OCCULTATION <0, DO NOT CONSIDER =0, STAR OCCULTATION >0, NUMBER OF FIRST STATION FOR VEHICLE OCCULTATION
		31-35	IXADD(17)	I5	NUMBER OF SECOND STATION
		36-40	IXADD(18)	I5	NUMBER OF THIRD STATION
		41-45	IXADD(20)	I5	NUMBER OF STATIONS TO BE CONSIDERED
17		OPEN			
18		OPEN			
19		OPEN			
20	END OF 2ND GROUP OF INPUTS				

2.2 INPUT FOR SUBDIVISION B1

Sect.	Card	Cols.	Name	Type	Description
	1	2-5	KSTDRD	I5	<0 WILL WANT AT LEAST SOME STANDARD INPUTS. ≥ 0 NO STANDARD. ALL VALUES WILL BE READ IN.
		6-10	IMODE	I5	=1 REAL DATA =2 SIMULATED DATA =3 ERROR ANALYSIS =4 PRELIMINARY SCAN =5 PROPAGATION OF ERRORS =6 MISS COEFFICIENTS
		11-15	PRECIS	F5.0	=1 LOW PRECISION LEVEL =2 INTERMEDIATE PRECISION LEVEL =3 HIGH PRECISION LEVEL
		16-20	CEPID	F5.0	=0,1 ENCKE INTEGRATION =-1 COWELL INTEGRATION
		21-25	ISUMRY	I5	=0 NO SUMMARY =1 SUMMARY
		26-30	ISTAT	I5	=0 MINIMUM VARIANCE =1 LEAST SQUARES

FIRST GROUP OF INPUTS

Sect.	Card	Cols.	Name	Type	Description
1	1	2-72	ITITLE(1-12)	12A6	TITLE
	2	2-5	NYEARP	I5	YEAR OF LAUNCH
		6-10	DAYS	F5.0	DAY OF LAUNCH YEAR
		11-15	HRS	F5.0	HOUR OF LAUNCH DAY
		16-20	HMIN	F5.0	MINUTE OF LAUNCH HOUR
		21-40	SEC	D20.16	SECONDS OF LAUNCH MINUTE
	3	1-24	TMAX	D24.12	TIME OF RUN IN HOURS
2	1	2-5	KLM	I5	INDICATOR FOR UNITS OF POSITION AND VELOCITY VECTOR =1 KM, KM/SEC =2 ER, ER/HR =3 FT, FT/SEC =4 MI, MI/HR =5 NM, NM/HR =6 NM, FT/SEC =7 AU, AU/HR
		6-10	KLM1	I5	INDICATOR FOR COORDINATE SYSTEM OF INPUT VECTORS =1 CARTESIAN COORD. WE=0 =2 CARTES. COMPUTE WE =3 GEODETIC LONG, LAT, ALT VE, VN, VH; WE =0 =4 GEODETIC LONG, LAT, ALT VE, VN, VH; COMPUTE WE =5 GEODETIC LONG, LAT, ALT $\lvert V\rvert$, γ, AZ; WE =0 =6 GEODETIC LONG, LAT, ALT $\lvert V\rvert$, γ, AZ; COMPUTE WE

Sect.	Card	Cols.	Name	Type	Description
					=7 GEOCENTRIC RA, DECL, ALT VRA, VD ,VH; WE=0
					=8 GEOCENTRIC RA, DECL, ALT VRA,VD , VH; COMPUTE WE
					=9 GEOCENTRIC RA, DECL, ALT $\lvert V \rvert$, γ, AZ; WE=0
					=10 GEOCENTRIC RA, DECL, ALT $\lvert V \rvert$, γ, AZ; COMPUTE WE
		11-15	KLM2	I5	INDICATOR FOR NUTATION AND PRECESSION OF INPUT VECTOR =0 NO =1 YES
		16-20	KSNAP	I5	INDICATOR FOR NUTATION AND PRECESSION OF VECTORS DURING RUN =0 NO =1 YES
		21-25	KLM3	I5	INDICATOR FOR LIBRATION OF INPUT VECTORS =0 NO =1 YES
		26-30	KLIBR	I5	INDICATOR FOR LIBRATION OF VECTORS DURING RUN =0 NO =1 YES
		31-35	MRREF	I5	INDICATOR FOR INITIAL REFERENCE BODY =1 EARTH =2 SUN =3 MOON =4 MARS =5 VENUS =6 JUPITER =7 SATURN
	2	1-24	RCIN(1)	D24.16	INITIAL POSITION VECTOR (VALUES DEPEND ON KLM1 AND KLM)
		25-48	(2)	D24.16	
		49-79	(3)	D24.16	
	3	1-24	RDCIN(1)	D24.16	INITIAL VELOCITY VECTOR (VALUES DEPEND ON KLM1 AND KLM)
		25-48	(2)	D24.16	
		49-72	(3)	D24.16	
3	1	2-5	IQZERO	I5	=0 USE INPUT Q MATRIX =1 USE GROWN Q MATRIX
		6-10	PASFX	F5.0	TOTAL NUMBER OF PASSES (1)
		11-15	PASS2	F5.0	TOTAL NUMBER OF PASSES (2)
		16-39	TMAX2	D24.16	TIME OF RUN FOR 2ND GROUP
4	1	2-5	KS2BY	I5	INDICATOR FOR TWO-BODY ONLY =0 NO =1 YES
		6-10	KSPLT	I5	INDICATOR FOR INCLUSION OF PLANETARY PERTURBATIONS =0 NO =1 YES

Sect.	Card	Cols.	Name	Type	Description
		11-15	KSOBL	I5	INDICATOR FOR INCLUSION OF OBLATENESS PERTURBATION =0 NO =1 YES
		16-20	KSDRG	I5	INDICATOR FOR INCLUSION OF EARTH DRAG PERTURBATION =0 NO =1 YES
		21-25	KSRAP	I5	INDICATOR FOR INCLUSION OF RADIATION PRESSURE PERTURBATION =0 NO =1 YES
		26-30	KSDRGM	I5	INDICATOR FOR INCLUSION OF MARS DRAG PERTURBATION =0 NO =1 YES
		31-35	KSDRGV	I5	INDICATOR FOR INCLUSION OF VENUS DRAG PERTURBATION =0 NO =1 YES
		36-40	KSMNOB	I5	INDICATOR FOR INCLUSION OF MOON OBLATENESS PERTURBATION =0 NO =1 YES
		41-45	KRF	I5	INDICATOR FOR INCLUSION OF REFRACTION EFFECTS =0 NO =1 YES
		46-50	KECLPS	I5	INDICATOR FOR INCLUSION OF ECLIPSE INFO PRINT =0 NO =1 YES
		51-55	KTC	I5	INDICATOR FOR INCLUSION OF TIME CORRECTION =0 NO =1 YES
		56-60	IRDATA	I5	INDICATOR FOR DATA REJECTION =0 NO =1 YES
5	1	2-5	MAXSTA	I5	TOTAL NUMBER OF STATIONS USED IN RUN
	2	2-5	K	I5	STATION NUMBER
		10-15	STANM(K)	4XA6	STATION NAME
		20-30	TYPE(K)	4XI11	A(1)+1.E2*A(2)+1.E4*A(3)+1.E6*A(4)+1.E8*K WHERE A= OBSERVATION TYPES USED BY STATION K IN ASCENDING ORDER
	3	1-24	STALT(K)	D24.16	LATITUDE OF STATION K
		25-48	STALN(K)	D24.16	LONGITUDE OF STATION K
		49-72	STAHT(K)	D24.16	ALTITUDE OF STATION K
	4	5-15	STATYP(K)	4XI11	ALL OBSERVATION TYPES THE STATION CAN MEASURE (SAME FORMAT AS TYPE (K))

Sect.	Card	Cols.	Name	Type	Description
	5	1-18	TDELAY(1,K)	E18.8	TIMES IN HRS, BEFORE WHICH
		19-36	TDELAY(2,K)	E18.8	EACH OBSERVATION IS NOT
		37-54	TDELAY(3,K)	E18.8	TO BE COMPUTED.
		55-72	TDELAY(4,K)	E18.8	
	6	1-18	FUP(K)	E18.8	STA. TRANSMIT. FREQ. (MC/S)
		19-36	FDOWN(K)	E18.8	STA. RECEIVE FREQ. (MC/S)
	7	1-24	STAOR(NCDST+1)	D24.16	ΔEE STA. ROTATION ANGLE
		25-48	STAOR(NCDST+2)	D24.16	ΔEV STA. ROTATION ANGLE
		49-72	STAOR(NCDST+3)	D24.16	ΔEN STA. ROTATION ANGLE
	8	1-24	STAOR(NCDST+4)	D24.16	ΔU STATION LOCATION
		25-48	STAOR(NCDST+5)	D24.16	ΔV ERRORS CAUSED BY
		49-72	STAOR(NCDST+6)	D24.16	ΔW GEODETIC NET ERROR
	9	1-24	STAOR(NCDST+7)	D24.16	NO REFRACTIVITY AT STA.
		25-48	STAOR(NCDST+8)	D24.16	H TROPOSPHERE SCALE FACT
		49-72	STAOR(NCDST+9)	D24.16	PO MAX. ELECTRON DENSITY
	10	1-24	STAOR(NCDST+10)	D24.16	HO LOWER LIMIT OF IONOSPHERE (KM)
		25-48	STAOR(NCDST+11)	D24.16	HM HT OF PO (KM)
		49-72	STAOR(NCDST+12)	D24.16	-OPEN-
	11	1-24	STAOR(NCDST+13)	D24.16	ΔT FOR TIMING
		25-48	STAOR(NCDST+14)	D24.16	BIAS ADDED FOR OBSER. A(1)
		49-72	STAOR(NCDST+15)	D24.16	BIAS ADDED FOR OBSER. A(2)
	12	1-24	STAOR(NCDST+16)	D24.16	BIAS ADDED FOR OBSER. A(3)
		25-48	STAOR(NCDST+17)	D24.16	BIAS ADDED FOR OBSER. A(4)
	13	1-72	TEBAR(1,J,K), J=1,4	4E18.8	COVARIANCE MATRIX
	14	1-72	TEBAR(2,J,K), J=1,4	4E18.8	FOR STATION K
	15	1-72	TEBAR(3,J,K), J=1,4	4E18.8	
	16	1-72	TEBAR(4,J,K), J=1,4	4E18.8	

REPEAT CARDS 2-16 FOR EACH STATION

Sect.	Card	Cols.	Name	Type	Description
6	1	1-18	DAREAS	E18.8	EFFECTIVE SURFACE AREA OF VEHICLE PERTAINING TO DRAG
		19-36	PAREAS	E18.8	EFFECTIVE SURFACE AREA PERTAINING TO RADIATION PRESSURE
		37-54	SPADD(6)	E18.8	MASS OF VEHICLE
7	1	2-5	MAXLUN	I5	MAXIMUM NUMBER OF LUNAR LANDMARKS
		6-10	IPLNT	I5	NUMBER OF PLANET TO BE USED FOR CALCULATING ONBOARD OBSERVATIONS
		11-15	ISTAR	I5	NUMBER OF STAR TO BE USED FOR CALCULATING ONBOARD OBSERVATIONS
	2	1-72	STAR(1,1-4)	4E18.8	TABLES NEEDED BY ON-BOARD
	3	1-72	STAR(1,5-8)	4E18.8	SUBROUTINE GIVING POSITIONS OF
	4	1-72	STAR(1,9-10), STAR(2,1-2)	4E18.8	REFERENCE STARS AND LANDMARKS. STAR(1,I) AND STAR(2,I) ARE DE-
	5	1-72	STAR(2,3-6)	4E18.8	CLINATION AND RIGHT ASCENSION,
	6	1-72	STAR(2,7-10)	4E18.8	RESPECTIVELY, OF THE ITH STAR.
	7	1-72	POSLUN(1,1-4)	4E18.8	POSLUN (1,I) AND POSLUN (2,I) ARE
	8	1-72	POSLUN(1,5-8)	4E18.8	LATITUDE AND LONGITUDE, RESPECTIVELY,
	9	1-72	POSLUN(1,9-10), POSLUN(2,1-2)	4E18.8	OF THE LANDMARK IN THE LUNAR COOR- DINATE SYSTEM.

Sect.	Card	Cols.	Name	Type	Description
	10	1-72	POSLUN(2,3-6)	4E18.8	
	11	1-72	POSLUN(2,7-10)	4E18.8	
8	1	2-5	IUNIT	I5	INDICATOR FOR OUTPUT UNITS (SEE KLM)
		6-10	KOPT	I5	INDICATOR OF DESIRED OPTION OF KSECPR ARRAY FOR PRINTING STATISTICS
		11-60	IPSEC(I), I= 1,10	10I5	INDICATORS FOR SUPPRESSION OF EACH OF 10 PRINT SECTIONS
	2	1-18	DTPI	E18.8	PRINT PORTION (HRS) OF TOTAL PRINT PERIOD
		19-36	DTSUP	E18.8	SUPPRESS PORTION (HRS) OF TOTAL PRINT PERIOD
		37-54	PRATE	E18.8	INDICATOR FOR USE OF ABOVE PRINT PERIOD
	3	1-24	DTP	D24.12	INCREMENT FOR PRINT TIME
9	1	2-5	NPFSET	I5	NUMBER OF POWERED FLIGHT SETS (UP TO 3)
	2	1-72	PFPAR(I,1-3)	3D24.12	TIME START, TIME END, FX
	3	1-72	PFPAR(I,4-6)	3D24.12	FY, FZ, MASS
	4	1-72	PFPAR(I,7-9)	3D24.12	MASS RATE,ΔT-INTEG,Δ-PNT

REPEAT CARDS 2-4 FOR EACH I WHERE I=1, NPFSET

Sect.	Card	Cols.	Name	Type	Description
10	1	2-5	MAXSTA	I5	NUMBER OF STATIONS USED
	2	2-5	KSTA	I5	STATION NUMBER
		6-25	KM(I),I=1,4	4I5	FREQUENCY OF ACCEPTANCE OF DATA TYPES
	3	1-72	EBRMLT(J,KSTA), J=1,4	4E18.8	ARRAY OF EBAR MATRIX MULTIPLIERS

REPEAT CARDS 2-3 FOR EACH STATION

Sect.	Card	Cols.	Name	Type	Description
11	1	1-5	NOFT	I5	NUMBER OF TIMES THROUGH BAYES FOR CONVERGENCE
		6-10	MXPASS	I5	MAXIMUM VALUE OF PASS COUNTER
	2	1-24	TOLSQ	D24.16	SQUARE OF TOLERANCE FOR CONVERGENCE
		25-48	TPRELM	D24.16	MAX. TIME OF PRELIMINARY BATCH
	3	1-72	TSPAN(1-3)	3D24.16	TIME SPAN OF EACH BATCH
	4	1-72	TSPAN(4-6)	3D24.16	TIME SPAN OF EACH BATCH
12	1	2-5	IPMAT	I5	INDICATOR FOR MATRIX INPUT =0 P MATRIX TO BE READ IN =1 Q MATRIX TO BE READ IN
	2-13	1-72	(QSAVE(I,J),J= 1,6),I=1,6)	3D24.12	P OR Q MATRIX DEPENDING ON IPMAT
13		-OPEN-			
14		-OPEN-			
15		-OPEN-			
16		-OPEN-			
17		-OPEN-			
18		-OPEN-			

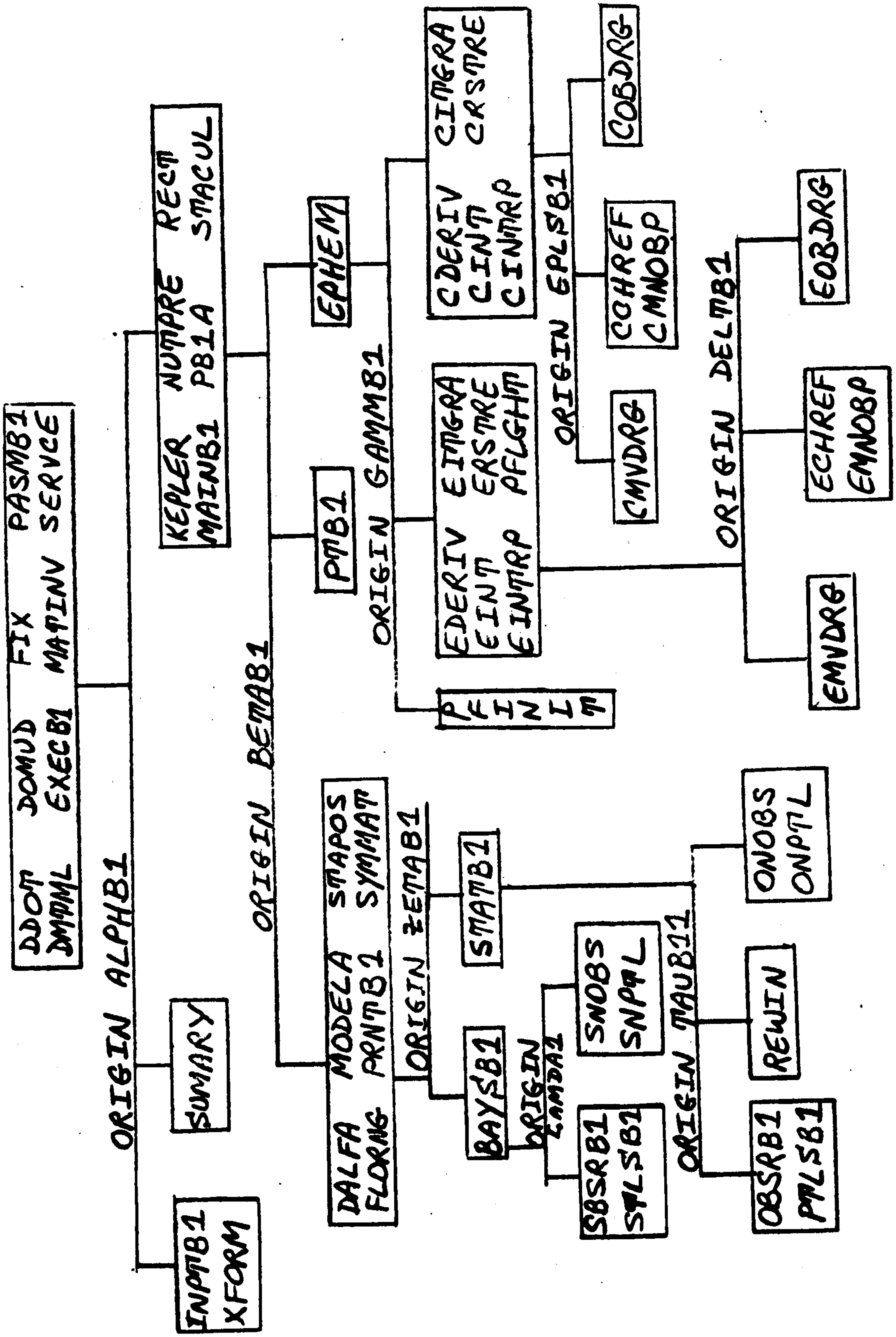

Figure 2

Overlay Structure for Subdivision B1

Sect.	Card	Cols.	Name	Type	Description
19		-OPEN-			
20		END OF FIRST SET OF INPUTS			

PROGRAM ADVANCES TO 2ND GROUP OF INPUTS. IF KSTDRD IS NEGATIVE, STANDARD VALUES ARE COMPUTED AND PROGRAM BEGINS TO READ IN 2ND SET OF INPUTS TO CHANGE OR AUGMENT ANY OF THESE STANDARDS. IF KSTDRD NOT NEGATIVE, ALL VALUES ARE READ IN, ELSE VALUES FROM PREVIOUS STACKED CASE ARE USED.

Sect.	Card	Cols.	Name	Type	Description
1	1-7	1-72	(DT3(I,J),I=1,3),J=1,7	3D24.12	INTEGRATION INTERVALS FOR EACH OF 7 WORKING BODIES FOR NEAR, MEDIUM AND FAR REFERENCE
2	1	1-72	R1(1-3)	3D24.12	R1 and R2 ARE DISTANCES IN E.R. FOR EACH OF 7 WORKING BODIES FOR SWITCHING FROM NEAR TO MEDIUM AND MEDIUM TO FAR INTEGRATION INTERVALS.
	2	1-72	R1(4-6)	3D24.12	
	3	1-72	R1(7),R2(1-2)	3D24.12	
	4	1-72	R2(3-5)	3D24.12	
	5	1-48	R2(6-7)	2D24.12	
3	1	1-24	RT1	D24.12	VALUES USED AS TOLERANCES IN RECTIFICATION CRITERIA
		25-48	RT2	D24.12	
4	1	1-18	DH1	E18.8	TROPOSPHERE INTEGRATION STEP SIZE (KM)
		19-36	DH2	E18.8	IONOSPHERE INTEGRATION STEP SIZE (KM)
		37-54	H2	E18.8	UPPER LIMIT TROPOSPHERE(KM)
		55-72	H4	E18.8	UPPER LIMIT IONOSPHERE(KM)
5	1	2-5	KOBLAT	I5	NUMBER OF OBLATENESS COEFFS.
	2	2-5	M	I5	M INDEX
		6-10	N	I5	N INDEX
		11-15	ISORC	I5	INDICATOR FOR C OR S COEFF. =0 S =1 C
	3	1-24	SORCCF	D24.12	VALUE OF COEFFICIENT

REPEAT CARDS 2-3 UNTIL KOBLAT VALUES HAVE BEEN READ IN.

Sect.	Card	Cols.	Name	Type	Description
6	1	2-5	MBMAX	I5	NUMBER OF WORKING BODIES
		6-	KWBMU(I),I=1, MBMAX	(MBMAX)*I5	INDICES OF WORKING BODIES
	2	1-72	TPMAT8(I),I=1, MBMAX	3D24.12	GRAVITATIONAL CONSTANTS OF WORKING BODIES

REPEAT CARD 2 FOR EACH VALUE OVER 3N NEEDED

Sect.	Card	Cols.	Name	Type	Description
7	1	1-24	DYN(48)	D24.12	SOLAR FLUX
		25-48	DYN(49)	D24.12	OPEN
8	1	1-72	DYN(51-53)	3D24.12	COEFFS. FOR LUNAR OBLATENESS
9	1	1-24	COMB(1)	D24.12	VELOCITY OF LIGHT
10	1	1-72	PRNT3(1-3)	3D24.12	PRINT INTERVALS (HRS) FOR NEAR MEDIUM AND FAR REFERENCE
11	1	1-24	EMIN	D24.12	MINIMUM ELEVATION ANGLE (RAD)
12	1	1-18	RTO	E18.8	RATIO OF NORDSIECK INTEGRATION INTERVAL TO THAT IN RUNGE-KUTTA

Sect.	Card	Cols.	Name	Type	Description
13		-OPEN-			
14	1	1-72	RATEV(1-3,1)	3D24.12	ROTATION VECTOR USED IN MARS DRAG COMPUTATIONS
	2	1-72	RATEV(1-3,2)	3D24.12	ROTATION VECTOR USED IN VENUS DRAG COMPUTATIONS
15	1-10	1-72	XMACH(I),I=1,40	4E18.8	MACH NUMBER TABLE
	11-20	1-72	CDT(I),I=1,40	4E18.8	DRAG COEFFICIENT TABLE
16	1	1-72	DELX(I),I=1,3	3D24.16	ARRAY OF CORRECTIONS TO THE STATE VARIABLES
	2	1-72	DELX(I),I=4,6	3D24.16	
17	1	1-18	REJCT1	E18.8	NUMBER OF STANDARD DEVIATIONS ABOVE WHICH DATA ARE REJECTED ON FIRST AND SUBSEQUENT PASSES, RESPECTIVELY
		19-36	REJCT2	E18.8	
18		-OPEN-			
19		-OPEN-			
20	END OF 2ND GROUP OF INPUTS				

2.3 INPUT FOR SUBDIVISION B2

Sect.	Card	Cols.	Name	Type	Description
	1	2-5	KSTDRD	I5	<0 WILL WANT AT LEAST SOME STANDARD INPUTS ≥0 NO STANDARD. ALL VALUES WILL BE READ IN.
		6-10	IMODE	I5	=1 REAL DATA =2 SIMULATED DATA =3 ERROR ANALYSIS =4 PRELIMINARY SCAN =5 PROPAGATION OF ERRORS =6 MISS COEFFICIENTS
		11-15	PRECIS	F5.0	=1 LOW PRECISION LEVEL =2 INTERMEDIATE PRECISION LEVEL =3 HIGH PRECISION LEVEL
		16-20	CEPID	F5.0	=0,1 ENCKE INTEGRATION =-1 COWELL INTEGRATION
		21-25	ISUMRY	I5	=0 NO SUMMARY =1 SUMMARY
		26-30	ISTAT	I5	=0 MINIMUM VARIANCE =1 LEAST SQUARES
FIRST GROUP OF INPUTS					
1	1	2-72	ITITLE(1-12)	12A6	TITLE
	2	2-5	NYEARP	I5	YEAR OF LAUNCH
		6-10	DAYS	F5.0	DAY OF LAUNCH YEAR
		11-15	HRS	F5.0	HOUR OF LAUNCH DAY
		16-20	HMIN	F5.0	MINUTE OF LAUNCH HOUR
		21-40	SEC	D20.16	SECONDS OF LAUNCH MINUTE
	3	1-24	TMAX	D24.12	TIME OF RUN IN HOURS
2	1	2-5	KLM	I5	INDICATOR FOR UNITS OF POSITION AND VELOCITY VECTOR =1 KM,KM/SEC =2 ER, ER/HR =3 FT,FT/SEC =4 MI,MI/HR =5 NM,NM/HR =6 NM,FT/SEC =7 AU,AU/HR

2.3 Cont'd

Sect.	Card	Cols.	Name	Type	Description
		6-10	KLM1	I5	INDICATOR FOR COORDINATE SYSTEM OF INPUT VECTORS =1 CARTESIAN COORD. WE=0 =2 CARTES. COMPUTE WE =3 GEODETIC LONG,LAT,ALT VE,VN,VH; WE =0 =4 GEODETIC LONG,LAT,ALT VE,VN,VH; COMPUTE WE =5 GEODETIC LONG,LAT,ALT $\|V\|$, γ, AZ; WE=0 =6 GEODETIC LONG,LAT,ALT $\|V\|$, γ, AZ; COMPUTE WE =7 GEOCENTRIC RA,DECL,ALT VRA,VD,VH; WE=0 =8 GEOCENTRIC RA,DECL,ALT VRA,VD, VH; COMPUTE WE =9 GEOCENTRIC RA,DECL,ALT $\|V\|$, γ, AZ; WE=0 =10 GEOCENTRIC RA,DECL,AL $\|V\|$, γ, AZ; COMPUTE WE
		11-15	KLM2	I5	INDICATOR FOR NUTATION AND PRECESSION OF INPUT VECTOR =0 NO =1 YES
		16-20	KSNAP	I5	INDICATOR FOR NUTATION AND PRECESSION OF VECTORS DURING RUN =0 NO =1 YES
		21-25	KLM3	I5	INDICATOR FOR LIBRATION OF INPUT VECTORS =0 NO =1 YES
		26-30	KLIBR	I5	INDICATOR FOR LIBRATION OF VECTORS DURING RUN =0 NO =1 YES
		31-35	MRREF	I5	INDICATOR FOR INITIAL REFERENCE BODY =1 EARTH =2 SUN =3 MOON =4 MARS =5 VENUS =6 JUPITER =7 SATURN

2.3 Cont'd

Sect.	Card	Cols.	Name	Type	Description
	2	1-24	RCIN(1)	D24.16	INITIAL POSITION VECTOR
		25-48	(2)	D24.16	(VALUES DEPEND ON
		49-79	(3)	D24.16	KLM1 AND KLM)
	3	1-24	RDCIN(1)	D24.16	INITIAL VELOCITY VECTOR
		25-48	(2)	D24.16	(VALUES DEPEND ON
		49-72	(3)	D24.16	KLM1 AND KLM)
3	1	2-5	IQZERO	I5	=0 USE INPUT Q MATRIX =1 USE GROWN Q MATRIX
		6-10	PASFX	F5.0	TOTAL NUMBER OF PASSES (1)
		11-15	PASS2	F5.0	TOTAL NUMBER OF PASSES (2)
		16-39	TMAX2	D24.16	TIME OF RUN FOR 2nd GROUP
4	1	2-5	KS2BY	I5	INDICATOR FOR TWO-BODY ONLY =0 NO =1 YES
		6-10	KSPLT	I5	INDICATOR FOR INCLUSION OF PLANETARY PERTURBATIONS =0 NO =1 YES
		11-15	KSOBL	I5	INDICATOR FOR INCLUSION OF OBLATENESS PERTURBATION =0 NO =1 YES
		16-20	KSDRG	I5	INDICATOR FOR INCLUSION OF EARTH DRAG PERTURBATION =0 NO =1 YES
		21-25	KSRAP	I5	INDICATOR FOR INCLUSION OF RADIATION PRESSURE PERTURB. =0 NO =1 YES
		26-30	KSDRGM	I5	INDICATOR FOR INCLUSION OF MARS DRAG PERTURBATION =0 NO =1 YES

2.3 Cont'd

Sect.	Card	Cols.	Name	Type	Description
		31-35	KSDRGV	I5	INDICATOR FOR INCLUSION OF VENUS DRAG PERTURBATION =0 NO =1 YES
		36-40	KSMNOB	I5	INDICATOR FOR INCLUSION OF MOON OBLATENESS PERTURBAT. =0 NO =1 YES
		41-45	KRF	I5	INDICATOR FOR INCLUSION OF REFRACTION EFFECTS =0 NO =1 YES
		46-50	KECLPS	I5	INDICATOR FOR INCLUSION OF ECLIPSE INFO PRINT =0 NO =1 YES
		51-55	KTC	I5	INDICATOR FOR INCLUSION OF TIME CORRECTION =0 NO =1 YES
		56-60	IRDATA	I5	INDICATOR FOR DATA REJECTION =0 NO =1 YES
5	1	2-5	MAXSTA	I5	TOTAL NUMBER OF STATIONS USED IN RUN
	2	2-5	K	I5	STATION NUMBER
		10-15	STANM(K)	4XA6	STATION NAME
		20-30	TYPE(K)	4XI11	A(1)+1.E2*A(2)+1.E4*A(3)+ 1.E6*A(4)+1.E8*K WHERE A= OBSERVATION TYPES USED BY STATION K IN ASCENDING ORDER
	3	1-24	STALT(K)	D24.16	LATITUDE OF STATION K
		25-48	STALN(K)	D24.16	LONGITUDE OF STATION K
		49-72	STAHT(K)	D24.16	ALTITUDE OF STATION K
	4	5-15	STATYP(K)	4XI11	ALL OBSERVATION TYPES THE STATION CAN MEASURE (SAME FORMAT AS TYPE(K))

2.3 Cont'd

Sect.	Card	Cols.	Name	Type	Description
	5	1-18	TDELAY(1,K)	E18.8	TIMES IN HRS. BEFORE WHICH EACH OBSERVATION IS NOT TO BE COMPUTED
		19-36	TDELAY(2,K)	E18.8	
		37-54	TDELAY(3,K)	E18.8	
		55-72	TDELAY(4,K)	E18.8	
	6	1-18	FUP(K)	E18.8	STA. TRANSMIT. FREQ.(MC/S)
		19-36	FDOWN(K)	E18.8	STA. RECEIV. FREQ.(MC/S)
	7	1-24	STAOR(NCDST+1)	D24.16	ΔEE STA. ROTATION ANGLE
		25-48	STAOR(NCDST+2)	D24.16	ΔEV STA. ROTATION ANGLE
		49-72	STAOR(NCDST+3)	D24.16	ΔEN STA. ROTATION ANGLE
	8	1-24	STAOR(NCDST+4)	D24.16	ΔU STATION LOCATION ERRORS
		25-48	STAOR(NCDST+5	D24.16	ΔV CAUSED BY
		49-72	STAOR(NCDST+6)	D24.16	ΔW GEODETIC NET ERROR
	9	1-24	STAOR(NCDST+7)	D24.16	NO REFRACTIVITY AT STA.
		25-48	STAOR(NCDST+8)	D24.16	H TROPOSPHERE SCALE FACT
		49-72	STAOR(NCDST+9)	D24.16	PO MAX. ELECTRON DENSITY
	10	1-24	STAOR(NCDST+10)	D24.16	HO LOWER LIMIT OF IONOSPHERE
		25-48	STAOR(NCDST+11)	D24.16	HM HT OF PO (KM)
		49-72	STAOR(NCDST+12)	D24.16	-OPEN-
	11	1-24	STAOR(NCDST+13)	D24.16	ΔT FOR TIMING
		25-48	STAOR(NCDST+14)	D24.16	BIAS ADDED FOR OBSER.A(1)
		49-72	STAOR(NCDST+15)	D24.16	BIAS ADDED FOR OBSER.A(2)
	12	1-24	STAOR(NCDST+16)	D24.16	BIAS ADDED FOR OBSER.A(3)
		25-48	STAOR(NCDST+17)	D24.16	BIAS ADDED FOR OBSER.A(4)
	13	1-72	TEBAR(1,J,K),J=1,4	4E18.8	COVARIANCE MATRIX FOR STATION K
	14	1-72	TEBAR(2,J,K),J=1,4	4E18.8	
	15	1-72	TEBAR(3,J,K),J=1,4	4E18.8	
	16	1-72	TEBAR(4,J,K) J=1,4	4E18.8	

REPEAT CARDS 2-16 FOR EACH STATION

Sect.	Card	Cols.	Name	Type	Description
6	1	1-18	DAREAS	E18.8	EFFECTIVE SURFACE AREA OF VEHICLE PERTAINING TO DRAG
		19-36	PAREAS	E18.8	EFFECTIVE SURFACE AREA PERTAINING TO RADIATION PRESSURE
		37-54	SPADD(6)	E18.8	MASS OF VEHICLE
7	1	2-5	MAXLUN	I5	MAXIMUM NUMBER OF LUNAR LANDMARKS
		6-10	IPLNT	I5	NUMBER OF PLANET TO BE USED FOR CALCULATING ONBOARD OBSERVATIONS
		11-15	ISTAR	I5	NUMBER OF STAR TO BE USED FOR CALCULATING ONBOARD OBSERVATIONS
	2	1-72	STAR(1,1-4)	4E18.8	TABLES NEEDED BY ON-BOARD SUBROUTINE GIVING POSITIONS OF REFERENCE STARS AND LANDMARKS. STAR (1,I) AND STAR (2,I) ARE DECLINATION AND RIGHT ASCENSION RESPECTIVELY, OF THE Ith STAR POSLUN (1,I) AND POSLUN (2,I) ARE LATITUDE AND LONGITUDE RESPECTIVELY, OF THE Ith LANDMARK IN THE LUNAR COORDINATE SYSTEM.
	3	1-72	STAR(1,5-8)	4E18.8	
	4	1-72	STAR(1,9-10), STAR(2,1-2)	4E18.8	
	5	1-72	STAR(2,3-6)	4E18.8	
	6	1-72	STAR(2,7-10)	4E18.8	
	7	1-72	POSLUN(1,1-4)	4E18.8	
	8	1-72	POSLUN(1,5-8)	4E18.8	
	9	1-72	POSLUN(1,9-10), POSLUN(2,1-2)	4E18.8	
	10	1-72	POSLUN(2,3-6)	4E18.8	
	11	1-72	POSLUN(2,7-10)	4E18.8	
8	1	2-5	IUNIT	I5	INDICATOR FOR OUTPUT UNITS (SEE KLM)
		6-10	KOPT	I5	INDICATOR OF DESIRED OPTION OF KSECPR ARRAY FOR PRINTING STATISTICS

2.3 Cont'd

Sect.	Card	Cols.	Name	Type	Description
		11-60	IPSEC(I),I=1,10	10I5	INDICATORS FOR SUPPRESSION OF EACH OF 10 PRINT SECTIONS
	2	1-18	DTPI	E18.8	PRINT PORTION (HRS) OF: SUPPRESS
		19-36	DTSUP	E18.8	PORTION (HRS) OF: TOTAL PRINT PERIOD
		37-54	PRATE	E18.8	INDICATOR FOR USE OF ABOVE PRINT PERIOD
	3	1-24	DTP	D24.12	PRINT INCREMENT
9	1	2-5	NCOMB	I5	NUMBER OF COMBINED BIASES
		6-10	NSB	I5	NUMBER OF STATION-ORIENTED BIASES
		11-15	NDB	I5	NUMBER OF DYNAMIC BIASES
	2	2-	MCOL(I),I=1,NDSVB	(NDSVB)*I5	CODES FOR BIASES WHERE NDSVB IS SUM OF NCOMB, NSB AND NDB
10	1	2-5	MAXSTA	I5	NUMBER OF STATIONS USED
	2	2-5	KSTA	I5	STATION NUMBER
		6-25	KM(I),I=1,4	4I5	FREQUENCY OF ACCEPTANCE OF DATA TYPES
	3	1-72	EBRMLT(J,KSTA), J=1,4	4E18.8	ARRAY OF EBAR MATRIX MULTIPLIERS
		REPEAT CARDS 2-3 FOR EACH STATION			
11	1	1-5	NOFT	I5	NUMBER OF TIMES THROUGH BAYES FOR CONVERGENCE
		6-10	MXPASS	I5	MAXIMUM VALUE OF PASS COUNTER
	2	1-24	TOLSQ	D24.16	SQUARE OF TOLERANCE FOR CONVERGENCE
		25-48	TPRELM	D24.16	MAX. TIME OF PRELIMINARY BATCH

2.3 Cont'd

Sect.	Card	Cols.	Name	Type	Description
	3	1-72	TSPAN(1-3)	3D24.16	TIME SPAN OF EACH BATCH
	4	1-72	TSPAN(4-6)	3D24.16	
12	1	2-5	IPMAT	I5	INDICATOR FOR MATRIX INPUT =0 P MATRIX TO BE READ IN =1 Q MATRIX TO BE READ IN
	2	1-72	(STAT(I,J),J=1,NBST), I=1, NBST	3D24.12	P OR Q MATRIX DEP. ON IPMAT WHERE NBST=TOTAL BIAS TYPES +6
13	1	1-	OFFSET(I), I=1, NDB	4E18.8	OFFSETS OF DYNAMIC BIASES
			REPEAT CARD 1 FOR EACH VALUE OVER 4N NEEDED		
14	1	1-	DELP(1-3)	3E18.8	OFFSETS OF 1ST 3 REFRAC- TION PARAMETERS
			DELP(4-6)	3E18.8	OFFSETS OF LAST 3 REFRAC- TION PARAMETERS SEE CARDS 10,11 OF SECTION 5
15	-OPEN-				
16	-OPEN-				
17	-OPEN-				
18	-OPEN-				
19	-OPEN-				
20	END OF FIRST GROUP OF INPUTS				

PROGRAM ADVANCES TO 2ND GROUP OF INPUTS. IF KSTDRD IS NEGATIVE, STANDARD VALUES ARE COMPUTED AND PROGRAM BEGINS TO READ IN 2ND SET OF INPUTS TO CHANGE OR AUGMENT ANY OF THESE STANDARDS. IF KSTDRD NOT NEGATIVE, ALL VALUES ARE READ IN, ELSE VALUES FROM PREVIOUS STACKED CASE ARE USED.

2.3 Cont'd

Sect.	Card	Cols.	Name	Type	Description
1	1-7	1-72	(DT3(I,J), I=1,3),J=1,7	3D24.12	INTEGRATION INTERVALS FOR EACH OF 7 WORKING BODIES FOR NEAR, MEDIUM AND FAR REFERENCE
2	1	1-72	R1(1-3)	3D24.12	R1 AND R2 ARE DISTANCES IN E.R FOR EACH OF 7 WORKING BODIES FOR SWITCHING FROM NEAR TO MEDIUM AND MEDIUM TO FAR INTEGRATION INTERVALS
	2	1-72	R1(4-6)	3D24.12	
	3	1-72	R1(7),R2(1-2)	3D24.12	
	4	1-72	R2(3-5)	3D24.12	
	5	1-48	R2(6-7)	2D24.12	
3	1	1-24	RT1	D24.12	VALUES USED AS TOLERANCES IN RECTIFICATION CRITERIA
		25.48	RT2	D24.12	
4	1	1-18	DH1	E18.8	TROPOSPHERE INTEGRATION STEP SIZE (KM)
		19-36	DH2	E18.8	IONOSPHERE INTEGRATION STEP SIZE (KM)
		37-54	H2	E18.8	UPPER LIMIT TROPOSPHERE(KM)
		55-72	H4	E18.8	UPPER LIMIT IONOSPHERE (KM)
5	1	2-5	KOBLAT	I5	NUMBER OF OBLATENESS COEFFS.
	2	2-5	M	I5	M INDEX
		6-10	N	I5	N INDEX
		11-15	ISORC	I5	INDICATOR FOR C OR S COEFF. =0 S =1 C
	3	1-24	SORCCF	D24.12	VALUE OF COEFFICIENT
		REPEAT CARDS 2-3 UNTIL KOBLAT VALUES HAVE BEEN READ IN.			
6	1	2-5	MBMAX	I5	NUMBER OF WORKING BODIES
		6-	KWBNU(I),I=1, MBMAX	(MBMAX)*I5	INDICES OF WORKING BODIES

2.3 Cont'd

Sect.	Card	Cols.	Name	Type	Description
	2	1-72	TPMAT8(I), I=1,MBMAX	3D24.12	GRAVITATIONAL CONSTANTS OF WORKING BODIES
		REPEAT CARD 2 FOR EACH VALUE OVER 3N NEEDED			
7	1	1-24	DYN(48)	D24.12	SOLAR FLUX
		25-48	DYN(49)	D24.12	OPEN
8	1	1-72	DYN(51-53)	3D24.12	COEFFS. FOR LUNAR OBLATENESS
9	1	1-24	COMB(1)	D24.12	VELOCITY OF LIGHT
10	1	1-72	PRNT3(1-3)	3D24.12	PRINT INTERVALS (HRS) FOR NEAR MEDIUM AND FAR REFERENCE
11	1	1-24	EMIN	D24.12	MINIMUM ELEVATION ANGLE (RAD)
12	1	1-18	RTO	E18.8	RATIO OF NORDSIECK INTEGRATION INTERVAL TO THAT IN RUNGE-KUTTA
13		-OPEN-			
14	1	1-72	RATEV(1-3,1)	3D24.12	ROTATION VECTOR USED IN MARS DRAG COMPUTATIONS
	2	1-72	RATEV(1-3,2)	3D24.12	ROTATION VECTOR USED IN VENUS DRAG COMPUTATIONS
15	1-10	1-72	XMACH(I),I=1,40	4E18.8	MACH NUMBER TABLE
	11-20	1-72	CDT(I),I=1,40	4E18.8	DRAG COEFFICIENT TABLE
16	1	1-	DELX(I),I=1,NBST	3D24.16	ARRAY OF CORRECTIONS TO THE STATE VARIABLES
		REPEAT CARD 1 FOR EACH VALUE OVER 3N NEEDED			

2.3 Cont'd

Sect.	Card	Cols.	Name	Type	Description
17	1	1-18	REJCT1	E18.8	NUMBER OF STANDARD DEVIATIONS
		19-36	REJCT2	E18.8	ABOVE WHICH DATA ARE REJECTED ON FIRST AND SUBSEQUENT PASSES, RESPECTIVELY
18		-OPEN-			
19		-OPEN-			
20	END OF 2ND GROUP OF INPUTS				

2.3.1 SPECIFICATION OF BIAS ERRORS

The user specifies which biases he wants included in section nine of the first group of inputs. In what follows, the intention is to clarify how to set up the proper codes for bias specification.

The first card in section nine reads in the following quantities:

NCOMB -*the number of combination type biases in the current run;

NSB - the number of station oriented biases

NDB - the number of dynamic biases

The sum of these three quantities is computed and a number of bias specifying codes equal to this sum is read in. Code numbers for combination type biases range from one to five, those for station-oriented biases from six to four hundred forty-seven and those for dynamic biases from four hundred forty-eight to five hundred-seven.

The breakdown is as follows:

Combination type Biases

Code	Bias
1	Velocity of light
2	Open
3	Open
4	Open
5	Open

* A "combination" bias is one which is equally applicable to all ground stations. Velocity of light, earth radius and earth's ellipticity are examples of this type of bias.

Station Oriented Biases

KSTA is station number
NCDST = 17*(KSTA–1)
Let N = NCDST + 5

There are seventeen bias types associated with any station. For a given station, with number KSTA, the codes are:

Code	Bias
N+1	Station location error, u direction
N+2	Station location error, u direction
N+3	Station location error, w direction
N+4	Station rotation angle, east
N+5	Station rotation angle, north
N+6	Station rotation angle, vertical
N+7	Refractivity at station
N+8	Tropospheric model scale factor
N+9	Maximum electron density
N+10	Height of bottom of ionosphere
N+11	Height of maximum electron density
N+12	Open
N+13	Delta–t for timing
N+14	Error in first observation type
N+15	Error in second observation type
N+16	Error in third observation type
N+17	Error in fourth observation type

Dynamic Biases

Code	Biases
448	C oblateness coefficient,m=2,n=2
449	C oblateness coefficient,m=1,n=2
450	C oblateness coefficient,m=0,n=2
451	C oblateness coefficient,m=3,n=3
452	C oblateness coefficient,m=2,n=3
453	C oblateness coefficient,m=1,n=3
454	C oblateness coefficient,m=0,n=3
455	C oblateness coefficient,m=4,n=4
456	C oblateness coefficient,m=3,n=4
457	C oblateness coefficient,m=2,n=4
458	C oblateness coefficient,m=1,n=4
459	C oblateness coefficient,m=0,n=4
460	C oblateness coefficient,m=3,n=5
461	C oblateness coefficient,m=2,n=5
462	C oblateness coefficient,m=1,n=5
463	C oblateness coefficient,m=0,n=5
464	C oblateness coefficient,m=2,n=6
465	C oblateness coefficient,m=1,n=6
466	C oblateness coefficient,m=0,n=6
467	C oblateness coefficient,m=1,n=7
468	C oblateness coefficient,m=0,n=7
469	C oblateness coefficient,n=0,n=8
470	C oblateness coefficient,m=0,n=9

Code	Bias
471	C oblateness coefficient,m=0,n=10
472	S oblateness coefficient,m=2,n=2
473	S oblateness coefficient,m=1,n=2
474	S oblateness coefficient,m=3,n=3
475	S oblateness coefficient,m=2,n=3
476	S oblateness coefficient,m=1,n=3
477	S oblateness coefficient,m=4,n=4
478	S oblateness coefficient,m=3,n=4
479	S oblateness coefficient,m=2,n=4
480	S oblateness coefficient,m=1,n=4
481	S oblateness coefficient,m=3,n=5
482	S oblateness coefficient,m=2,n=5
483	S oblateness coefficient,m=1,n=5
484	S oblateness coefficient,m=2,n=6
485	S oblateness coefficient,m=1,n=6
486	S oblateness coefficient,m=1,n=7
487	Gravitational constant of Earth
488	Gravitational constant of Sun
489	Gravitational constant of Moon
490	Gravitational constant of Mars
491	Gravitational constant of Venus
492	Gravitational constant of Jupiter
493	Gravitational constant of Saturn
494	Area-to-mass ratio for radiation pressure
495	Solar flux
496	Open
497	Area-to-mass ratio for air drag
498	A coefficient for lunar oblateness
499	B coefficient for lunar oblateness
500	C coefficient for lunar oblateness
501	Open
502	Open
503	Open
504	Open
505	Open
506	Open
507	Open

3. General Description of Output

In each of the three program subdivisions, the output is broken down into several sections. The user has the option of choosing any or all of these sections for printing during a particular run.

A great deal of flexibility exists in the choice of times at which to print. The user can specify an overall interval (labelled TAU) which is composed of a print portion (DTPI) and a suppress portion (DTSUP).

If the input variable PRATE is negative, printing takes place each time the print subroutine is entered during the print portion of the interval TAU. When PRATE is positive, it is used as a time interval, in hours, at which printing takes place in the DTPI portion of TAU.

The following sections describe the quantities which the user may specify as output in each of the three program subdivisions.

3.1 Output Options in Subdivision A

In Subdivision A, there are ten print sections. The following lists the output quantities which a particular section prints.

Section 1

Program time in hours since launch;

Current program date in hours, minutes, seconds, day and year;

Planetary body which is the current reference.

Section 2

Station number;

Observation types which station handles.

Section 3

Components and magnitudes of position and velocity vectors in units specified by the user.

Section 4

Components and magnitudes of perturbations in position, velocity and acceleration in units specified by the user.

Section 5

Components and magnitudes of vectors between vehicle and each planetary body in specified units.

Section 6

Components and magnitudes of vectors between the earth and each of the other planetary bodies in specified units.

Section 7

Components and magnitudes of vectors between the sun and each of the other planetary bodies in specified units.

Section 8

Right ascension;

Declination;

Greenwich hour angle;

Longitude and latitude of earth subsatellite point;

Geocentric altitude, azimuth and elevation;

Geodetic azimuth and elevation.

Section 9

True, eccentric and mean anomalies;

Eccentricity;

Inclination;

Argument of perigee;

Perigee passage time;

Right ascension of ascending node;

Period;

Mean motion;

Semi-major axis;

Perigee and apogee heights.

Section 10

Station name;

Program time in hours;

Station location;

Observation values.

Section 8 of the first group of inputs reads in the quantities by which the user designates the type and frequency of output desired. The inclusion of any of the ten output sections described above is specified by a positive value in the corresponding element of the array IPSEC.

3.2 Output Options in Subdivision B1

In Subdivision B1, the printing is done by three subroutines, viz., PB1A, PRNTB1 and PTB1. This multiplicity of output routines was dictated by the need to conserve storage and fits well into the established overlay structure.

3.2.1 Output Associated with Trajectory Computations

Subroutine PB1A performs the function of testing if it is time to print. If so, it prints those Sections of Sections 1 and 3 (described in 3.1) which are specified in the IPSEC array. Then, if the quantity in the calling sequence is non-zero and any of Sections 4 through 9 (also described in 3.1) are specified in the IPSEC array, PB1A calls subroutine PTB1. The latter prints the designated Sections.

3.2.2 Output Associated with Statistical Computations

Subroutine PRNTB1 is assigned to the statistical link of the overlay structure. Its function is the printing of quantities associated with the Least Squares or Minimum Variance computations.

The output is divided into fifteen sections, only one of which can be printed at each call to PRNTB1. The section to be printed is specified in the calling sequence.

If KPRINT (an indicator set in PB1A at print times) is non-zero or if the indicator MFLAG is positive, the designated element of the indicator matrix, KSECPR, is tested. When it is non-zero, the section specified in the calling sequence is printed. The sections available for printing are as follows:

Section	Output
1	State Transition Matrix, PHI
2	Point Transformation Matrix, S
3	Covariance Matrix, Q Update
4	Observation Matrix, M
5	Observation Matrix, N
6	EBAR Matrix
7	Covariance of Observations Matrix, Y

Section	Output
8	Inverse of Y Matrix
9	Optimum Filter Matrix, L
10	Covariance Matrix, Q Corrected
11	Covariance Matrix, P
12	Array of Parameter Residuals
13	Array of Residuals of States
14	Station Number and Data Types
15	Station Name, Observation Values and Time

The indicator KOPT is read in Section 8 of the first group of inputs.

3.3 Output Options in Subdivision B2

In Subdivision B2, the printing is done by three subroutines, viz., BPRA2, BPRB and BPTA2. Here, as in B1, use of the overlay structure to conserve storage led to a multiplicity of output subroutines.

3.3.1 Output Associated with Trajectory Computations

The discussion in Section 3.2.1 applies exactly here when BPRA2 is substituted for PB1A and BPTA2 for PTB1.

3.3.2 Output Associated with Statistical Computations

The discussion in Section 3.2.2 applies exactly here when BPRB is substituted for PRNTB1.

4. Operating Procedures

All runs are set up as jobs under the IBSYS/IBJOB Operating System. Each of the program subdivisions is composed of a distinct set of decks. The overlay feature of IBJOB is used by each subdivision and the appropriate control cards are required for defining the overlay structure.

The operational aspects of the Orbit Determination Program will be described in detail for use under the "Stand-Alone" 7090/7094. The approach for its operation under the 7040-7094 Direct-Coupled System will also be described.

4.1 Typical Deck Set Up

Consider the overlay diagram for Subdivision A (Figure 1). The deck set-up to run a job would be as follows:

Columns:	1	8	16
	$JOB		
	$EXECUTE		IBJOB
	$IBJOB		GO, MAP, NOFLOW
	$IBLDR	DMTML	
	binary deck for DMTML		
	$IBLDR	DOMUD	
	binary deck for DOMUD		
	$IBLDR	EXECA	
	binary deck for EXECA		
	$ORIGIN		ALPHA
	$IBLDR	INPUTA	
	binary deck for INPUTA		

```
Columns:    1                 8                16

            $IBLDR            XFORM
              binary deck for XFORM
            $ORIGIN                            ALPHA
            $IBLDR            ATIM
              binary deck for ATIM
            $IBLDR            DDOT
              binary deck for DDOT
            $IBLDR            EPHEM
              binary deck for EPHEM
            $IBLDR            FIX
              binary deck for FIX
            $IBLDR            MAINA
              binary deck for MAINA
            $IBLDR            MODELA
              binary deck for MODELA
            $IBLDR            NUTPRE
              binary deck for NUTPRE
            $IBLDR            OBD
              binary deck for OBD
            $IBLDR            OBSERA
              binary deck for OBSERA
            $IBLDR            PRINTA
              binary deck for PRINTA
            $IBLDR            SERVCE
              binary deck for SERVCE
```

```
Columns:    1            8            16

$IBLDR             STACUL
  binary deck for STACUL
$IBLDR             STAPOS
  binary deck for STAPOS
$IBLDR             TIMNGA
  binary deck for TIMNGA
$ORIGIN                        BETA
$IBLDR             CDERIV
  binary deck for CDERIV
$IBLDR             CINT
  binary deck for CINT
$IBLDR             CINTRP
  binary deck for CINTRP
$IBLDR             CITGRA
  binary deck for CITGRA
$IBLDR             CRSTRE
  binary deck for CRSTRE
$ORIGIN                        GAMMA
$IBLDR             COBDRG
  binary deck for COBDRG
$ORIGIN                        GAMMA
$IBLDR             CMVDRG
  binary deck for CMVDRG
$ORIGIN                        GAMMA
$IBLDR             CCHREF
  binary deck for CCHREF
```

```
Columns:   1                8              16

           $IBLDR           CMNOBP
             binary deck for CMNOBP
           $ORIGIN                         BETA
           $IBLDR           EDERIV
             binary deck for EDERIV
           $IBLDR           EINT
             binary deck for EINT
           $IBLDR           EINTRP
             binary deck for EINTRP
           $IBLDR           EITGRA
             binary deck for EITGRA
           $BLDR            ERSTRE
             binary deck for ERSTRE
           $IBLDR           KEPLER
             binary deck for KEPLER
           $IBLDR           PFLGHT
             binary deck for PFLGHT
           $IBLDR           RECT
             binary deck for RECT
           $ORIGIN                         DELTA
           $IBLDR           EOBDRG
             binary deck for EOBDRG
           $ORIGIN                         DELTA
           $IBLDR           EMVDRG
             binary deck for EMVDRG
```

Columns:	1	8	16
	$ORIGIN		DELTA
	$IBLDR	ECHREF	
	binary deck for ECHREF		
	$IBLDR	EMNOBP	
	binary deck for EMNOBP		
	$ORIGIN		BETA
	$IBLDR	PFINIT	
	binary deck for PFINIT		
	$ENTRY		EXECA
	$DATA		
	Deck containing Specifications Input		
	$IBSYS		

In the above deck set-up the $IBLDR control card and the binary deck for a subroutine may be replaced by a $IBFTC control card and the source deck for the subroutine.

4.2 Tape Assignments

The tape unit containing the pre-stored program and data deck is mounted on SYSIN1.

Other tape units referred to by the various subdivisions are logical units 8, 9, 10 and 11. The corresponding tapes should be mounted on drives in accordance with the Tape Assignment Table in effect at the particular installation.

Logical Tape 8 contains the required tables of planetary positions. It is used by all program subdivisions.

Logical Tape 9 is the observation data tape. In Subdivision A, a scratch tape should be mounted on logical unit 9 when in the mode calling for a simulated data tape to be produced. In Subdivisions B1 and B2, those modes calling for observational data require a data (real or simulated) tape on logical unit 9.

Logical Tape 10 is used for Summary information. Therefore, a scratch tape should be mounted on logical unit 10 when running Subdivisions B1 or B2.

Logical Tape 11 is used as a temporary store for various quantities by Minimum Variance and Bayes statistics. A scratch tape on logical unit 11 is therefore required in Subdivisions B1 and B2.

An additional option of the overlay features is the use of tapes to share the function of the Load File Tape (see the IBJOB manual for description). These additional tapes shorten the amount of time necessary for the loader to locate a particular link to be brought into core.

This option is specified by placing the system unit name (such as SYSUT2), onto which the dependent link is to be written, on the $ORIGIN control card preceding that link. Each distinct system unit name thus specified requires a scratch tape to be mounted on the drive corresponding to the system unit.

When running under the Direct-Coupled System, the following differences are to be noted:

(a) SYSIN1 and SYSOU1 no longer require tape drives:

(b) Any other unit not specified on a $SETUP control card will automatically be assigned to the Disc. Hence, $SETUP cards are required for the Ephemeris tape (logical unit 8) and the observation data tape (logical unit 9). It is recommended that $SETUP cards also be used for the tapes on which the dependent links are written, for speed of operation.

4.3 Subdivision B2

Up until now, Subdivision B2 has been treated as a complete program in itself, having much the same structure as Subdivision B1. However, the current version of the IBSYS system requires so much memory that it is not possible to fit the longest link of Subdivision B2 into core.

As a result, Subdivision B2 has been divided into two separate sub-programs, B2(A) and B2(B). B2(A) uses only Minimum Variance for its statistical processing and B2(B) uses only Bayes Estimation.

It is expected that later versions (viz., 12 and 13) of IBSYS will require much less memory for system purposes, thus allowing B2(A) and B2(B) to be recombined to Subdivision B2.

Figures 3 and 4 present the overlay diagrams of Sub-programs B2(A) and B2(B). Figure 2 shows the overlay structure of Subdivision B1.

Logical Tape 9 is the observation data tape. In Subdivision A, a scratch tape should be mounted on logical unit 9 when in the mode calling for a simulated data tape to be produced. In Subdivisions B1 and B2, those modes calling for observational data require a data (real or simulated) tape on logical unit 9.

Logical Tape 10 is used for Summary information. Therefore, a scratch tape should be mounted on logical unit 10 when running Subdivisions B1 or B2.

Logical Tape 11 is used as a temporary store for various quantities by Minimum Variance and Bayes statistics. A scratch tape on logical unit 11 is therefore required in Subdivisions B1 and B2.

An additional option of the overlay features is the use of tapes to share the function of the Load File Tape (see the IBJOB manual for description). These additional tapes shorten the amount of time necessary for the loader to locate a particular link to be brought into core.

This option is specified by placing the system unit name (such as SYSUT2), onto which the dependent link is to be written, on the $ORIGIN control card preceding that link. Each distinct system unit name thus specified requires a scratch tape to be mounted on the drive corresponding to the system unit.

When running under the Direct-Coupled System, the following differences are to be noted:

(a) SYSIN1 and SYSOU1 no longer require tape drives:

(b) Any other unit not specified on a $SETUP control card will automatically be assigned to the Disc. Hence, $SETUP cards are required for the Ephemeris tape (logical unit 8) and the observation data tape (logical unit 9). It is recommended that $SETUP cards also be used for the tapes on which the dependent links are written, for speed of operation.

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Figures 3 and 4 present the overlay diagrams of Subprograms B2(A) and B2(B). Figure 2 shows the overlay structure of Subdivision B1.

4.4 Recommended Optional Procedures

Certain techniques can be employed to give more efficiency of operation in the running of the Orbit Determination Program. Consider the user who desires to run Subdivision B1 with the Encke option of integration exclusively.

The following modifications can then be made to the program deck:

(a) CITGRA can be replaced by a dummy subroutine. (It cannot be removed entirely, since a CALL CITGRA statement is present in subroutine MAINB1.)

(b) The binary decks for subroutines CINT, CCHREF, CRSTRE, CDERIV, COBDRG, CINTRP, CMVDRG, CMNOBP can be removed.

This will shorten the size of the program deck and hence minimize loading time on the computer. The same approach can also be taken if the user wants to use one method of statistical processing, for example, Bayes Estimation.

To avoid the deck handling problems, all programs can be pre-stored on tape, each subdivision occupying a different file. Then, a particular run can be made with a very small input deck by making use of the $IEDIT control card of the IBJOB Input/Output Editor.

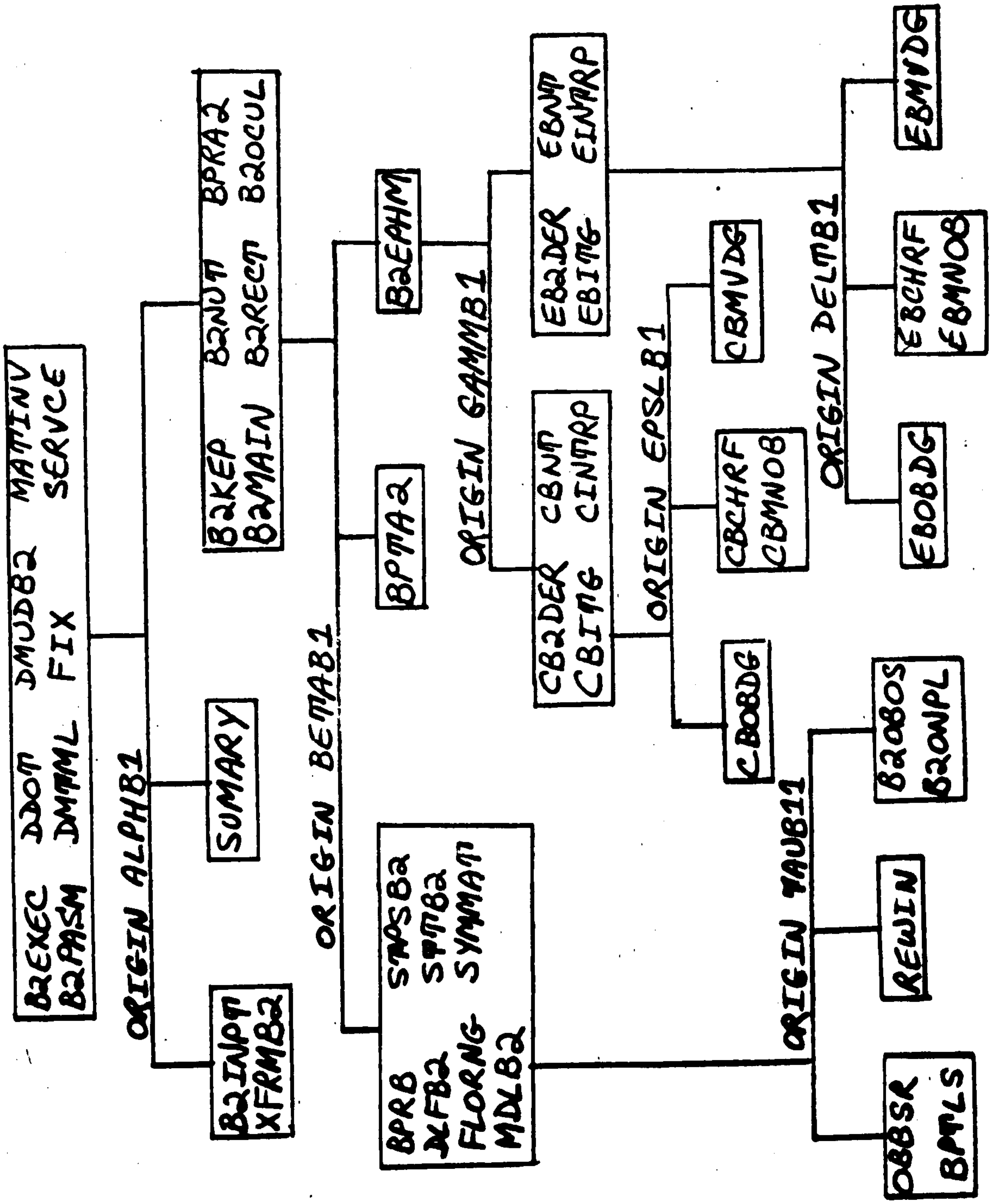

Figure 3

Overlay Structure for Subdivision B2(A)

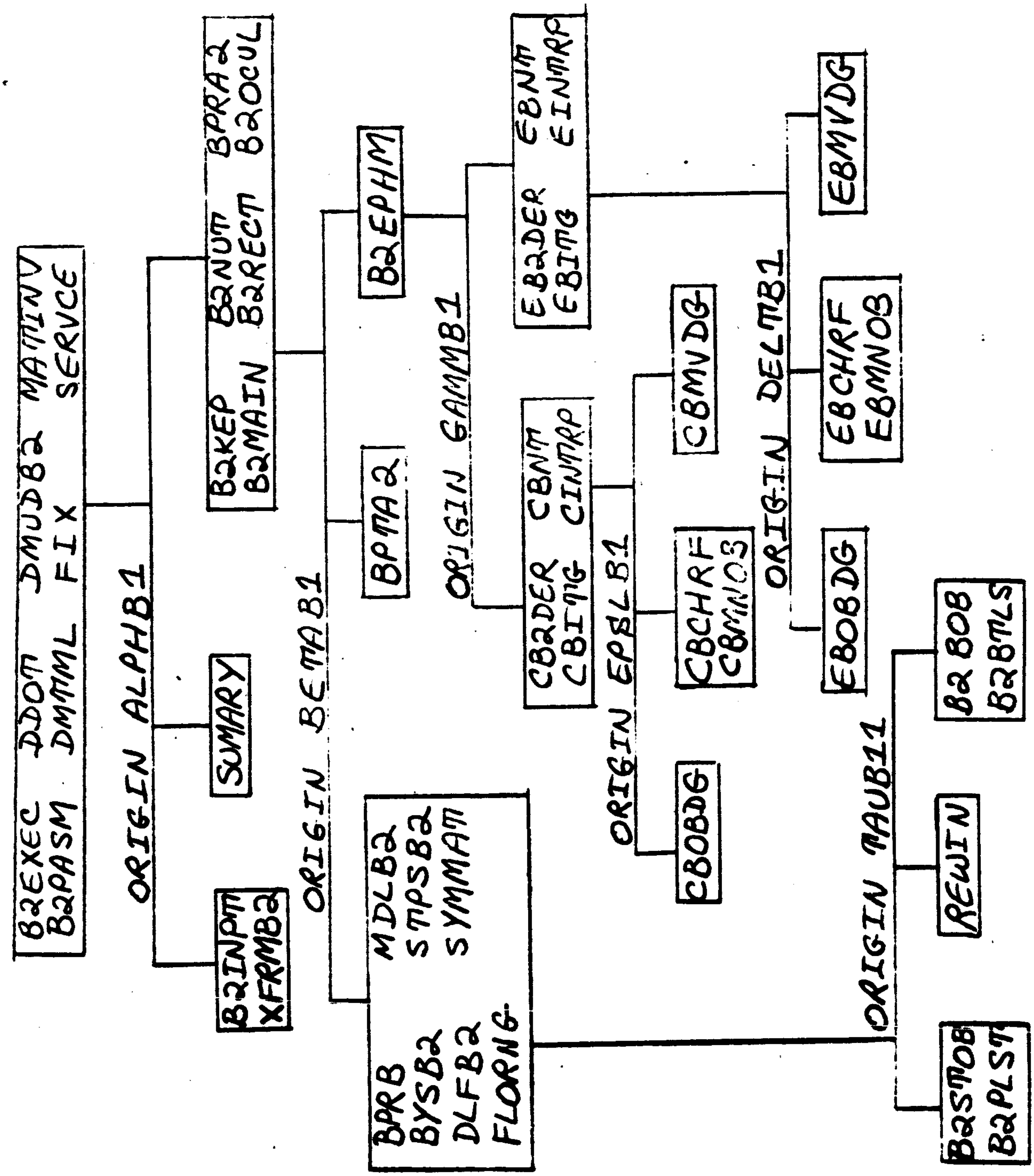

Figure 4

Overlay Structure for Subdivision B2(B)